

ECONOMIC ANALYSIS – FLOOD DAMAGE REDUCTION

Lower Carmel River Floodplain Restoration and Enhancement Project

I. Description of the Project and its Relationship to Other Projects in the Proposal

The Lower Carmel River Floodplain Restoration and Enhancement Project (Project) would provide the combined benefits of enhanced flood protection for a portion of flood prone areas in the immediate vicinity of the north bank of the Carmel River east of Highway One and habitat enhancement in the lower 2 miles of the Carmel River floodplain. The Project compliments the Carmel River Lagoon and Beach Studies Sub-Project (Sub-Project) by focusing on completing flood protection benefits in the lower two miles of the Carmel River and completes over 20 years of phased improvements for habitat and flood control enhancement in the area. The project would result in both a physical and hydrologic connection to the Carmel River Lagoon therefore restoring the physical function of the now separated floodplain and lagoon ecosystem.

The Carmel River Lagoon and Beach Studies Sub-Project begins the feasibility phase for identifying a possible flood control and habitat improvement project in the reach of the Carmel River that includes the lagoon, lower half mile of the river channel and the seasonal barrier beach at the river mouth. This feasibility work will examine solutions to avoid flood damages to 24 homes and solutions to managing the Carmel River Lagoon to avoid mechanized breaching of the lagoon. The potential engineered solution to be examined includes a beach barrier wall to be constructed within the north side of the lagoon.

The Project and Sub-Project are the primary flood benefit projects in the Monterey Peninsula, Carmel Bay, and South Monterey Bay Integrated Regional Water Management Plan (IRWM Plan) affecting over 200 residences as well as significant commercial areas, public facilities, and agricultural operations. Much of the focus of the IRWM Plan is the restoration and enhancement of the region's primary water supply watershed and the region's most important ecological feature: the Carmel River. Projects in this proposal package focus on all of the primary issues associated with the Carmel River Watershed: water supply and overdraft on the system, habitat degradation through loss of habitat and habitat disruption, flood damages to urban and agricultural resources, and decline of physical and hydrologic function of the lower Carmel River ecosystem. The Project and Sub-Project also compliments the Carmel River Watershed Volunteer program proposed in this package in that it would provide a project which could be included in the volunteer monitoring efforts and assessments for improvements in the watershed.

II. Description of the Project's Economic Costs and Benefits

The Project involves three major cost items: (1) project design, engineering and environmental review, (2) construction of the flood conveyance causeway and utility relocation, and (3) removal of earthen levees and earthwork for flood channel overbank capacity and finish grading for habitat improvements.

The project will be completed in two main phases. Phase One will be completed from May 2011 – December 2011. Phase One will include:

1. Creating a 36-acre agricultural preserve that is out of the 100-year floodplain
2. Preparing a base area to receive fill from Phase Two of the project
3. Completing rough grade elevations for seasonal wetlands and riparian habitats
4. Initial riparian and wetland plantings

Phase One of the Project is not proposed for funding in this IRWM Implementation Grant as it has sufficient funds to be completed at this time. However, the planning and construction implementation done for Phase One and as they relate to the proposed Phase Two portion of the project are considered opportunity costs and therefore will be included as an economic benefit for the Project as a whole. These Phase One benefits total \$1,564,000 in construction costs for Phase One.

Phase Two will include:

1. Construction of the flood conveyance causeway
2. Excavation of approximately 1,400 feet of the south bank levee for improved overflows into the Odello east property
3. Deposit of fill consisting of the levee excavation material onto the base area created in Phase One
4. Detailed finish grading for final flood conveyance and habitat restoration

This IRWM Grant Proposal requests funding for costs associated with the construction of the flood conveyance structure and excavation and grading associated with levee removal and flood flow conveyance.

The major costs items for the construction of the Project and its phases are summarized as follows in 2009 dollars. Details of these costs are included in Table 7.

Cost Item	Total Estimated Cost
Land Donation Value	1,500,000
Project Design, Engineering and Environmental Review	\$1,520,000
Construct Flood Conveyance Causeway Structure	\$9,231,635
Levee Removal and Deposition of Fill and Detailed Grading	\$3,150,000

Additional Project Economic Benefits: Opportunity Costs for Avoided Capital Costs

It is important to note that construction of the flood conveyance causeway and removal of the levees to create new capacity for flood flows on the south bank Odello property results in two opportunity costs for the Project area, notably for the CSA 50 area and Highway One, and will provide planning and construction related economic benefits within the local and regional economy. Short term economic benefits associated with professional services necessary for project design and construction, materials

purchased for construction, and actual construction of project improvements are expected to occur in 2011 and 2013.

The opportunity costs to CSA 50 and Highway One are related to future capital improvements that will need to be completed in the Project area within the next 10 years and which were recommended in the Philip Williams & Associates 2002 report and have been identified by Cal Trans.

CSA 50 Area: These improvements include the construction of levee and flood wall improvements on the north bank of the river from Mission Fields Little League Field to the east end of Val Verde Road and installation of greater capacity pumps for handling a wider range of storm events. Both of these improvements would be positively affected by the proposed Project capital improvements and both improvements would likely be less costly due to reduced size, length, and capacity because flood flows would be greatly reduced in these areas. These improvements were estimated to cost \$3,300,000 in the 2002 Philip Williams & Associates report. These improvements will be re-evaluated once the Project is built with an anticipated reduction in project costs.

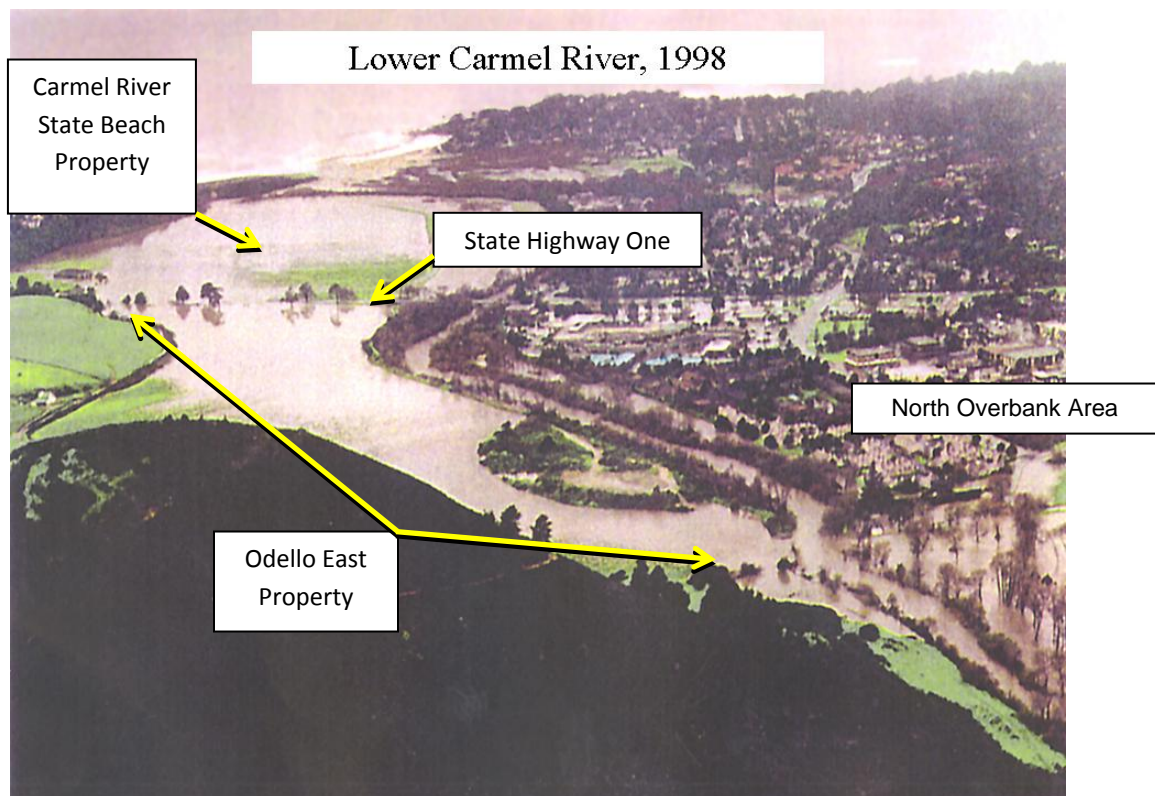
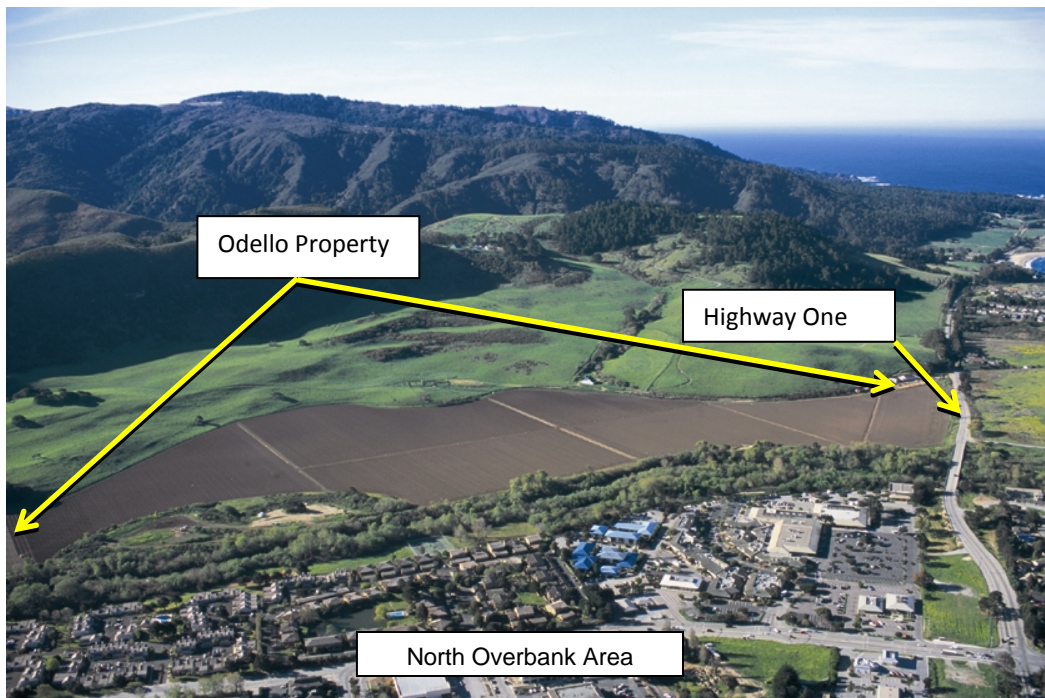
Highway One and Caltrans Maintenance Costs: Another opportunity cost which will result from the construction of the project will be the reduced costs of maintaining the existing 4 - 30" culverts under Highway One and the replacement of the culverts over their lifetime. Cal Trans had programmed these replacements in the next 10 years at an estimated cost of \$1,000,000 replacement cost for the four culverts. The flood conveyance causeway will eliminate the need for at least two and likely three of these culverts and will provide an area under Highway One which will not be restricted for flood flows or associated debris with flood flows.

III. Expected Flood Damage Reduction Benefits

Historical Flood Damage in the Project Area

The area of the proposed Project has sustained numerous floods throughout the years with documented floods occurring from 1911 through present years. The most damaging floods on record include the 1955, 1958, 1995, and 1998 floods. Damage estimates for 1995 and 1998 are available through Monterey County Water Resources Agency. The 1995 flood affected properties and public facilities in the project area causing an estimated \$7 million in damages in 1995 dollars (\$10,520,000 in 2009 dollars). These damages included the complete loss of the State Highway One Bridge and flood damage to residential and commercial properties including 220 residences in Mission Fields and flooding of the Crossroads commercial complex and Rio Road commercial businesses. The loss of the Highway One Bridge resulted in elimination of access to Carmel Highlands and Big Sur for six weeks and necessary evacuations by helicopter for those areas. The bridge was replaced at an estimated cost of \$5 million in 1995 (replacement cost is \$5,700,000 in 2009 dollars). Also during the 1995 and 1998 events, sewage treatment was disrupted in the lower Carmel River residential and commercial areas. A State of Emergency was declared during both these events.ⁱ

Figure 1 shows the Project area and Figure 2 shows the Project area during the 1998 flood.



The following photos show Carmel River Bridge washing away in 1995 flood.



Highway 1 Bridge over the Carmel River
Above - March 10, 1995
Below - March 12, 1995



The Project area affects three land areas in the lower floodplain which include a number of private homes, public facilities, and commercial businesses. These land areas are described below and denoted on the figures.

(a) South Side River Lands (Odello East and West Properties): Lands on the south side of the river include the Odello agricultural lands on the east side of Highway One, State Park land at Carmel River State Beach and Odello West, and the Carmel Area Wastewater District entry road and facility. The total land area is approximately 300 acres on the south side of the River. This area receives flood waters from events larger than a 20-year flood resulting in effects to agricultural operations at Odello East, restricting public access and recreation at Carmel River State Beach, and restricting access to the road to the Carmel Area Wastewater District Sewage Treatment Facility.

Estimated damage from a flood event to Odello East property includes loss of agricultural revenues from crop loss and damages estimated at \$240,000. The basis for this is agricultural lease value of \$30,000 per acre at an operational acreage of 8 acres of land. This is a conservative estimate of possible farmable acreage which is closer to 36 acres total but assumes only a portion of the crop may be damaged by flood waters in any given event.

Additional damages which may occur and have in the past include damage to the access road for the Carmel River Wastewater Facility and disruption of access to Carmel River State Beach. These are estimated at \$50,000 from historical flood events and repair necessary for the Carmel Area Wastewater District facility access road. This road was damaged in the 1995 flood and needed replacement.

(b) CSA-50 Service Area/North Bank of River: Land and developed area included in County Service Area No. 50 (CSA 50) a county designated assessment service area. The total area within CSA 50 boundary consists of 146.8 developed acres. Flood events in excess of the 20-year storm impact this area. For the purposes of this discussion the *Benefit Quantification included in the Lower Carmel River Flood Control Project Final Report, August 2002, pp. 44-52* have been used and updated to 2009 values. ⁱⁱ

The Benefit Quantification identified three land use types that would be impacted by flooding within the CSA 50 area: low-density residential, medium-density residential and commercial. The estimated number of residential units and commercial area square footage of each these land use types in the CSA-50/North Bank area is included in the following table for a 50-year and 100-year storm.

50-year Storm	No. of units/square footage affected	100-year Storm	No. of units/square footage affected
LDR units	170	LDR units	198
MDR units	54	MDR units	167
Commercial	848,000	Commercial	1,163,000

According to the Monterey County Flood Management Plan the mean annual flood damage for repetitive loss reports for residential properties in CSA 50 is \$1,092,644 with a low of \$109,264 and a

high of \$2,076,023. These are estimates from 2002 analysis based on 1995 flood data. 2009 values for these are \$1,300,247 for the mean, \$130,024 for the low, and \$2,470,467 for the high.

(c) State Highway One: State Highway One traverses the floodplain from north to south and includes the Carmel River Bridge a slab structure bridge rebuilt in 1995 after the flood of March 1995 destroyed the bridge and washed it away. The 1995 flood was estimated as a 20 - 25-year flood event. State Highway One is susceptible to flooding during events larger than a 10-year event and can sustain damage in larger flood events (see following discussion HEC-RAS modeling of flood elevations at Highway One). The bridge replacement cost in 1995 was \$5 million dollars. This value is \$5,700,000 in 2009 dollars using the update factor 1.41 provide by the Department of Water Resources.ⁱⁱⁱ

The total historic damages from flood events occurring from the Carmel River in the Project area is was \$7,000,000 in 1995 dollars and included the Highway One Bridge, CAWD access road, and damages to Crossroads and Rio Road commercial areas and residential units in Mission Fields and north bank areas . Values for these damages in 2009 dollars is \$10,520,000 based on a discount factor provided by Department of Water Resources.

Existing Without-Project Conditions

A number of analyses have been conducted for the “without-project” conditions for the flood events in the Project area. These studies and analyses include:

- U.S. Army Corps of Engineers, Flood Plain Information Carmel River, Prepared for Monterey County, 1967.
- Federal Emergency Management Agency, Flood Insurance Study for Monterey County – Unincorporated Areas, 1991.
- Nolte and Associates, Lower Carmel River Flood Control Report: Engineering Report, 1989.
- Monterey County Water Resources Agency, Repetitive Loss Report for Monterey County, unpublished.
- Balance Hydrologics, Inc., Design Alternatives Analysis for Floodplain Restoration at the Odello property, prepared for the Big Sur Land Trust, May 2007.
- Balance Hydrologics Inc., Supplemental Analyses for Floodplain Restoration at the Odello Property, Prepared for the Big Sur Land Trust, June 2008.
- Monterey County Water Resources Agency, Monterey County Flood Management Plan, 2008 Update.
- Federal Emergency Management Agency, Effective Flood Insurance Study for Carmel River, April 2, 2009.

These studies and reports have shown that there is a number of properties (residential and commercial) and public facilities in the floodplain of the Carmel River that experience flood damages during events larger than a 25-year storm and occurrences of damages from lesser storm events (10-year).

The estimated 100-year flood event is 23,300 cfs by the Federal Emergency Management Agency.^{iv} The peak flow of record on the Carmel River was the March 10, 1995 flood event which was gauged at 16,000 cfs estimated as equivalent to a 20 to 30-year flood.

According to recent analysis utilizing the U.S. Army Corps of Engineers HEC-RAS software and conducted by Balance Hydrologics, Inc.^v flood prone areas in the Project vicinity for the existing 100-year analysis are summarized as follows:

- Carmel Area Wastewater District Sewage Treatment Plant – Flooding depths of 4 feet on average were estimated at this facility. Flows in this area were estimated at 6200 cfs.
- State Highway One and associated commercial businesses – The highway as it crosses the south river floodplain area at Odello East would be inundated to a maximum depth of 3.6 feet with a total inundation width of 1,200 feet. 2-5 feet flooding depth was predicted at Carmel River Inn. Flows in this area were estimated at 15,000 cfs.
- CSA 50 (North Bank of River) – Depths of less than one foot of overtopping at north bank levee were modeled along the north bank upstream of Highway One along Val Verde Drive. Flows in this area were estimated at 2500 cfs.

Modeling results for the 10-year event indicate significantly reduced flooding impacts with the primary point of concern at Highway One where the road crosses the south overbank at Odello Fields. Flows were estimated to overtop the roadway at a maximum depth of 1.5 feet; however, this estimate is likely conservative given that the model did not take into account the large storage volume that exists in the south overbank behind the raised highway that can potentially attenuate the peak flow generated from a 10-year event.^{vi}

An overall assessment of the modeling results suggests that under existing conditions the Odello East and West lands are being utilized to some extent to route flow away from the main channel and the north overbank areas during floods. From a flood control perspective this benefits the developed north overbank at the cost of increased overtopping downstream of Highway One. These studies also demonstrated that flood protection alternatives such as removing the levees only or lowering the levees would disrupt this balance and result in increased flooding impacts in one location or another. For this reason the Project was developed to include the flood conveyance causeway as a necessary feature for increased flood protection in the area along with levee removal and habitat restoration.

Future With-Project Conditions

The Project that is proposed includes the construction of a 500-foot flood conveyance structure at Highway One in the south overbank area adjacent to the Odello East property (**see Figure 4 of Work Plan**). Other proposed actions include excavation of approximately 1400 linear feet of the south bank levees, fine grading of the levees and floodplain to allow flows into Odello East, and habitat restoration. According to the 2007 *Balance Hydrologics, Inc. Design Alternative Analysis for Floodplain Restoration at the Odello Property*, the added conveyance provided by the causeway would allow for increased flood flows to be routed through the south overbank areas of Odello East and West and would result in

lowering water surface elevations along the north overbank area, without resulting in an increase in the magnitude and frequency of the overtopping at Highway One.

The modeling results from these project improvements project a reduction in flooding within the north overbank can be achieved during the 100-year flow event. Projected reductions in flow rates is 20 percent of existing flow rates and water surface elevations are projected to be reduced 0.8 feet to 2.8 feet. Flow depths within the Odello property were also shown to drop allowing for the terraced agricultural preserve area to remain dry during events smaller than the 10-year flood.

According to the 2007 Balance Hydrologics, Inc. analysis, modeling results also indicated that Highway One would no longer be inundated during the 100-year flood event and that the Odello property would see a 53 percent increase in flow at Highway One. The subsequent decrease in flow within the main channel downstream of Highway One would result in lowering water surface elevations adjacent to the Mission Fields neighborhood by approximately 1.2 to 2.9 feet during the 100-year flood.

Methods Used to Estimate Without- and With- Project Conditions

All analyses used to develop the project description and goals were developed using HEC-RAS software utilizing the 2008 FEMA Flood Insurance Maps. Additional modeling was conducted utilizing the Finite Element Surface Water Modeling System-Two Dimensional Hydrodynamic (FESWMS-2DH) coupled with the Surface-water Modeling System (SMS) graphical pre- and post-processor software. This modeling platform is widely accepted and recommended by Caltrans for use in modeling highway river crossing where complex hydraulic conditions exist. All work was performed between 2007 and 2008 by Balance Hydrologics, Inc.

IV. Description of the Distribution of Local, Regional, and Statewide Benefits, as Applicable

The Project addresses a well-documented flood prone area in the lower Carmel River. Its benefits have local, regional and statewide economic benefits. Local benefits include reduction of damages to residences, commercial businesses and local infrastructure and facilities. Avoiding these damage costs is expected to benefit the local government and local economy. Regional and statewide benefits include prevention of loss of sales tax revenue from the area and protection of state infrastructure including State Highway One and Carmel River State Beach; both state owned properties. Carmel, Carmel Valley, and the Big Sur area receive over 13 million visitors annually which benefits both local and state economies. The Project will help prevent loss of access to these important statewide tourism areas including up three State Parks in the immediate area and six others in Big Sur.

The Lower Carmel River Floodplain Restoration Project will also help protect the local community against effects of global warming. Projections for climate change impacts on California's coast include more violent and intense flooding events as well as a rise in sea level by as much as three feet. Restoring and conserving functional floodplain area in the coastal zone is consistent with the Coastal Zone Protection Act of 1996, which urges states and communities to manage coastal development so as to minimize the loss of life and property caused by improper development in areas likely to be affected by or vulnerable to sea level rise.^{vii} The natural estuary/floodplain will provide a protective buffer against

sea level changes better than any man-made system of levees would be able to provide, while eliminating the potential for additional development in the coastal zone. Furthermore, restoring floodplain, riparian, and wetland vegetation to the project site will help increase carbon uptake and contribute to reduced CO₂ loading in the atmosphere.

V. Identification of Beneficiaries, When the Benefits will be Received, Uncertainty of Benefits and Description of Any Adverse Effects

The beneficiaries of the Project will be the properties within Project area described above. This includes approximately 220 structures of either residential or commercial nature. The Project will also benefit the Carmel River and its habitats, including the Carmel River Lagoon, all of which are important public trust resources for the State of California. The Project will result in approximately 90 acres of restored habitat for the Carmel River.

The flood reduction benefits of the project can be realized by 2013 after construction of the flood conveyance causeway and levee removal. The associated habitat improvements will take approximately five years to mature for wildlife benefit. Water quality benefits related to sediment and nutrient deposition on the floodplain are expected to be immediate benefits as well after construction in 2013. Benefits are not expected to be uncertain or adverse if the Project can be constructed according to design and can be implemented within a reasonable time frame of one another.

Effectiveness could be affected if Phasing is delayed between Phase One and Two of the Project, although increased damages would not result from such a delay. However, the flood control benefits would not be realized if Phase Two was not completed due to the inability to remove the south bank levees if the flood conveyance structure was not constructed. It has been determined through project modeling that the levees cannot be removed to allow flood flows into the south bank and Odello East area unless the flood conveyance structure is built due to flooding at Highway One.

ⁱ Monterey County Water Resources Agency, *Monterey County Flood Management Plan*, 2008 Update.

ⁱⁱ Philip Williams & Associates, Ltd., *Lower Carmel River Flood Control Project Final Report*, August 9, 2002, Prepared for Monterey County Water Resources Agency and County Services Area 50.

ⁱⁱⁱ Update factor provided by Department of Water Resources by email December 29, 2010.

^{iv} FEMA, *Effective Flood Insurance Study for Carmel River*, April 2, 2009

^v Balance Hydrologics, Inc. Design Alternatives for Flood plain restoration at the Odello Property, prepared for the Big Sur Land Trust, May 2007.

^{vi} Balance Hydrologics, Inc. May 2007.

^{vii} National Oceanic and Atmospheric Administration, Coastal Zone Management Act of 1972 as amended through P.L. 104-150, The Coastal Zone Protection Act of 1996. 16 U.S.C. §1452. Congressional declaration of policy (Section 303).